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OCCUPATIONAL HEALTH AND SAFETY IN THE AGRICULTURAL SECTOR: A BIBLIOMETRIC ANALYSIS USING RSTUDIO AND VOSVIEWER

TARIM SEKTÖRÜNDE İŞ SAĞLIĞI VE GÜVENLİĞİ: RSTUDIO VE VOSVIEWER KULLANARAK BİBLİYOMETRİK BİR ANALİZ

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ABSTRACT

The aim of this study is to analyze scientific publications in the field of occupational health and safety in the agricultural sector using bibliometric methods to evaluate publication trends, prominent topics, and collaboration networks. The literature review and dataset consist of a total of 774 articles published between 1981 and 2025 from the Web of Science database. RStudio and VOSviewer software were used to map the bibliometric network data. The analysis evaluated annual publication numbers, the most cited studies, authors, institutions, journals, keywords, and collaboration networks. The findings indicate that research on the agricultural sector has increased in recent years, reaching a peak in publications and citations in 2022. The most productive author in the study was Risto H. Rautiainen, while the institution that published the most articles was the University of Nebraska Medical Center, based in the United States. The most productive and influential resource on the subject was the US-based Journal of Agromedicine. In their early studies, researchers focused on the keywords "farm injuries," "accidents," "wounds and injuries," and "epidemiology." Trend analyses revealed keywords such as agricultural machinery, tractors, child labour, mental health, stress, ergonomics, and accessibility as emerging trends.

Keywords: Agricultural sector, bibliometric analysis, farm safety, occupational health and safety

ÖZET

Bu çalışmanın amacı, tarım sektöründe iş sağlığı ve güvenliği alanındaki bilimsel yayınları bibliyometrik yöntemlerle analiz ederek yayın eğilimlerini, öne çıkan konuları ve iş birliği ağlarını değerlendirmektir. Literatür taraması ve veri seti, Web of Science veritabanından 1981 ile 2025 yılları arasında yayınlanmış toplam 774 çalışmadan oluşmaktadır. Bibliyometrik ağ verilerini haritalamak için RStudio ve VOSviewer yazılımları kullanılmıştır. Analizde yıllık yayın sayıları, en çok atıf alan çalışmalar, yazarlar, kurumlar, dergiler, anahtar kelimeler ve iş birliği ağları değerlendirilmiştir. Bulgular, tarım sektörü üzerine yapılan araştırmaların son yıllarda arttığını ve 2022'de yayın ve atıflarda zirveye ulaştığını göstermektedir. Çalışmadaki en üretken yazar Risto H. Rautiainen iken, en çok makale yayınlayan kurum Amerika Birleşik Devletleri merkezli Nebraska Üniversitesi Tıp Merkezi olmuştur. Konuyla ilgili en üretken ve etkili kaynak ABD merkezli "Journal of Agromedicine" olmuştur. Erken dönemde yürütülen çalışmalarda, "çiftlik yaralanmaları", "kazalar", "yaralar ve yaralanmalar" ve "epidemioloji" anahtar kelimeleri öne çıkmaktadır. Trend analizleri, tarım makineleri, traktörler, çocuk işçiliği, ruh sağlığı, stres, ergonomi ve erişilebilirlik gibi anahtar kelimelerin yükselen trendler olduğunu ortaya koymaktadır.

Anahtar Kelimeler: Tarım sektörü, bibliyometrik analiz, çiftlik güvenliği, iş sağlığı ve güvenliği

INTRODUCTION

In today's free market and rapidly evolving technological environment, businesses must achieve high productivity to remain competitive. However, it should not be forgotten that there is a positive correlation between production levels and workplace accidents (Owusu-Boadi et al., 2023). Approximately half of the world's population lives in rural areas, and agriculture accounts for 28% of global employment. However, structural changes in the agricultural sector and unattractive employment conditions pose critical challenges to the sustainability of the rural workforce (Zhang & Kim, 2025). Agricultural workers are one of the most vulnerable groups exposed to occupational health risks, yet they do not have adequate protection against these risks at the global level. Promoting decent work is essential for achieving sustainable development. According to the International Labour Organization (ILO)'s definition, decent work is a comprehensive concept that encompasses various working conditions, including agriculture (Malanski et al., 2021). This complex situation requires identifying current trends in agriculture, synthesizing development and change, and determining and developing humane policies and practices related to occupational health and safety (OHS).

The agricultural sector harbors hazards and risks due to population growth, increased comfort, and advancing technology. The high prevalence of child labor and the informal economy are significant issues in the agricultural sector. Furthermore, the sector involves activities conducted in open areas that are sensitive to climate and weather conditions, often involving hazardous activities. Low wages and part-time work negatively affect worker retention. Agricultural activities involve heavy and physically demanding work, exposure to chemicals, biological hazards, UV radiation, noise, used tractors and other agricultural machinery and traffic, all of which pose various risks (Ekmekçi & Yaman, 2024; Baykut et al., 2023; Linde et al., 2022; Akay et al., 2021; Taş, 2021; Ünal et al., 2008). All these factors contribute to the occurrence of occupational accidents and diseases. According to ILO estimates, approximately 3 million workers die each year due to occupational accidents and diseases. Agriculture, construction, forestry, fishing, and manufacturing are among the most dangerous sectors, with accidents in these sectors causing 200,000 fatal injuries annually. This accounts for more than 60% of all fatal workplace accidents (ILO, 2023).

The economic impacts of workplace accidents and occupational diseases manifest at the micro, mezzo, and macro levels. Both direct and indirect costs are quite high. Addressing these issues requires comprehensive and multidimensional strategies. Approaches such as education, technology, supervision, and improving the working environment are the most effective ways to reduce economic costs and increase worker welfare. Investing in OHS is not a choice, but a necessity for a sustainable workforce and economic growth (Kart & Miser, 2025). Today, OHS professionals face a variety of complex issues. These issues relate to the working atmosphere, work organization, changes, haste, and psychosocial factors. To address these issues, a multidisciplinary approach to cooperation is required between workers, employers, and other actors in the field (Husman & Husman, 2006).

OHS has become an indispensable part of society due to rising global injury and death rates. Accordingly, employers, governments, and stakeholders have developed critical measures to protect human health; they have identified risks and hazards in the workplace and carried out efforts to prevent injuries and deaths (Otolaiye & Abd Aziz, 2024). Despite the fact that many countries around the world have developed OSH policies, strategies, and programs in recent years, there are still shortcomings in the implementation of OSH regulations, and workplace accidents occur frequently. This situation indicates gaps both in legislation and in its implementation (Zhang et al., 2020). The infrastructure and institutional and human resources required to implement strategies are inadequate in most countries (implementation gap). Although the estimated scope of services is low, only a quarter of the total global working population has access to OSH (coverage gap). The content and multidisciplinary nature of OSH correspond to international guidance, but due to infrastructure deficiencies and insufficient multidisciplinary human resources, the scope, comprehensiveness, and content of services are largely lacking (capacity gap) (Jain et al., 2021).

The primary objective of this study is to systematically examine the position and developmental dynamics of occupational health and safety OHS research conducted in the agricultural sector within the academic literature through bibliometric analysis methods. Within this scope, the historical evolution of the relevant body of literature, its geographical distribution, the most prolific authors, institutions, and journals, as well as the dominant thematic trends, have been analyzed within a comprehensive and integrative framework. Accordingly, knowledge production processes in the field of OHS in agriculture have been mapped through quantitative indicators, and research clusters, collaboration networks, and conceptual concentrations have been identified. Based on the findings, gaps in the

literature have been determined, and strategic as well as conceptual research opportunities have been proposed to guide future studies.

MATERIALS AND METHODS

Data gathering

Although the number of bibliographic data sources and metrics has increased significantly over the past decade, Web of Science (WoS) and Scopus remain the two primary and most comprehensive sources of publication metadata and impact indicators (Pranckutė, 2021). To collect research data, the WoS Core Collection database was used. This database having the most selective journal coverage (Singh et al., 2021) was preferred especially due to its advanced search queries, the convenience it provides in the data collection process and its extensive content. Web of Science provides access to an archive dating back to 1864 on a single platform, content from over 34,000 journals, over 235 million detailed metadata records, over 2.9 billion citation links for use in research, and a standardized and enriched database covering 254 subject categories (WoS, 2025).

In bibliometric studies, keywords associated with publications are fundamental elements representing the knowledge structure of the research field (Chen & Xiao, 2016) and serve as important “features” representing the semantic context of various elements such as authors, institutions, and citations (Chen et al., 2024). Therefore, it is important to determine the keywords that will form the basis of the research. The keywords “agricultural sector” and “occupational health and safety” form the basis of the study. In order to shape the keywords based on this main structure, studies containing bibliometric analysis related to the agricultural sector and OHS were examined through a preliminary literature review (Liu et al., 2025; Ekmekçi & Yaman, 2024; Malanski et al., 2019). The terms obtained were checked using the AGROVOC agricultural concept index. AGROVOC is a multilingual, open-access dictionary designed to cover concepts and terminology related to the areas of interest of the Food and Agriculture Organization of the United Nations (FAO) (FAO, 2020).

The search query design must be tested several times to ensure it retrieves the correct articles (Madani & Weber, 2016). Following the trials, it was decided that the keywords would consist of two headings. OR and AND Boolean operators were used to link the keywords. To prevent irrelevant matches unrelated to OSH, TS=(NOT “animal health” OR “plant health” OR “soil health” OR “food safety”) was added to the query. The main headings and keywords used for the search query are shown in Figure 1. No restrictions were placed on the search query in terms of publication type, language, or date. While searching the WoS Core Collection database, the following criteria were used: “TS = (“occupation health and safety” OR “occupation safety” OR “occupation health” OR “occupation safety and health” OR “occupational disease” OR “agricultural safety and health ” OR “agricultural health and safety” OR “agricultural safety” OR “agricultural injury” OR “agricultural injuries” OR “farm injuries” OR “farm injury” OR “farm fatalities” OR “farm safety” OR “agricultural hazard* ”) and TS = (“agriculture” OR “agricultural sector*” OR “farm sector*” OR “farming” OR “family farm*”OR “agricultural activities” OR “agricultural worker*” OR “agricultural work*” OR “farm worker*” OR “seasonal worker*” OR “temporary worker*” OR “farmworker*” OR “farm labour*”) and not TS=(“animal health” OR “plant health” OR “soil health” OR “food safety”) Languages = ‘All languages’ Document types = ‘All document types’ Time span = ‘All year’ Database = All in WoSCore Collection”.

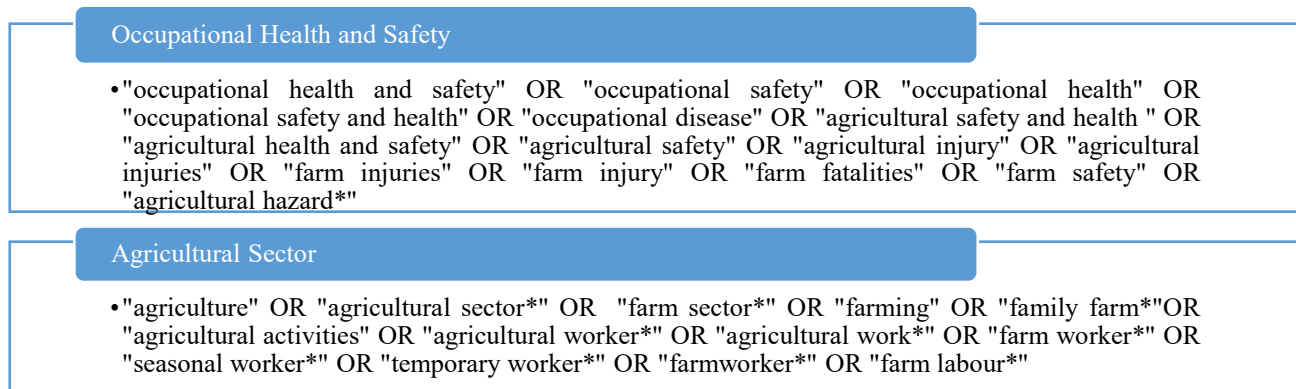


Figure 1. The Search Query

The search was conducted on June 12, 2025, through the WoS Core Collection database via the Kayseri University Library. No restrictions have been imposed on the search query with regard to publication type or language. It is evident that no filter has been applied for the year in question. This is due to the imprecise time frame of the studies, which hinders the ability to obtain results that encompass the earliest published research. In order to enhance the efficacy of the search results and to mitigate the presence of irrelevant matches, the keywords TS=(NOT 'animal health' OR 'plant health' OR 'soil health' OR 'food safety') have been incorporated into the query. The search yielded 774 studies. The earliest studies were published in 1981, and the time range of the publications was determined to be 1981-2025.

Methodology

A bibliometric analysis method was used to evaluate the dataset obtained regarding OHS in the agricultural sector. Bibliometric analysis is used to interpret large volumes of unstructured data meticulously, deciphering and mapping the cumulative scientific knowledge and evolutionary nuances of established fields (Donthu et al., 2021; Pekşen & Barman, 2024). Since bibliometric analysis comprehensively examines studies conducted in the field, allows for the observation of trends in research topics over the years and It provides ideas to new researchers through scientific maps and performance analyses (Durmuş & Gücüyeter, 2024). In this study, a total of 774 publications indexed in the WoS database and published between 1981 and 2025 were analyzed using Excel for performance analysis and VOSviewer (1.6.20) for mapping bibliometric network data. VOSviewer is a software tool used to create and visualize bibliometric networks based on data downloaded from bibliographic databases such as Web of Science and Scopus (Perianes-Rodriguez et al., 2016; VOSviewer, 2025). VOSviewer was chosen specifically because it places particular emphasis on the graphical representation of bibliometric maps and facilitates the interpretation of large bibliometric maps by displaying them easily (Van Eck & Waltman, 2010). Additionally, the Biblioshiny interface of the R Studio program was used in the preparation of thematic maps, the presentation of the distribution of keywords over time, and the creation of bibliometric analyses and network maps. The Bibliometrix R package provides a range of tools for quantitative research in bibliometric and scientific measurements. It is written in the R language, which is an open-source environment and ecosystem (Aria & Cuccurullo, 2017).

RESULTS AND DISCUSSION

The findings obtained in this section are presented to include the general descriptive characteristics of the studies conducted in the field (year, country, author, journal, research areas, number of citations, etc.) and the connections and clusters revealed by scientific mapping (keyword, country, author, institution, etc.). Table 1 contains descriptive data for 774 studies. Between 1981 and 2025, 774 studies were published in 266 different journals by 2477 authors. The studies have an average of 16.18 citations per document and a 12.02% international co-authorship rate. The documents used in this study contain 20,367 references, 1,195 keywords, and 1,940 author keywords.

Table 1. The Primary Information About Study

Main Information About Data		Languages	
Timespan	1981-2025	English	756
Sources (Journals, Books, etc)	266	German	5
Documents	774	French	3
Annual Growth Rate %	6.09	Korean	2
Document Average Age	11.3	Polish	2
Average citations per doc	16.18	Document Types	
References	20367	article	672
Document Contents		article; book chapter	3
Keywords Plus (ID)	1195	article; early access	3
Author's Keywords (DE)	1940	article; proceedings paper	13
Authors		editorial material	17
Authors	2477	letter	1
Authors of single-authored docs	55	meeting abstract	2
Authors Collaboration		note	3
Single-authored docs	57	proceedings paper	14
Co-Authors per Doc	4.59	review	46
International co-authorships %	12.02		

The data covers the period from 1981 to 2025, and the distribution of publications and citations is presented in Figure 2. According to this, the highest number of publications was reached in 2022 with 49 publications. The highest number of citations was also in 2022 with 1109 citations.

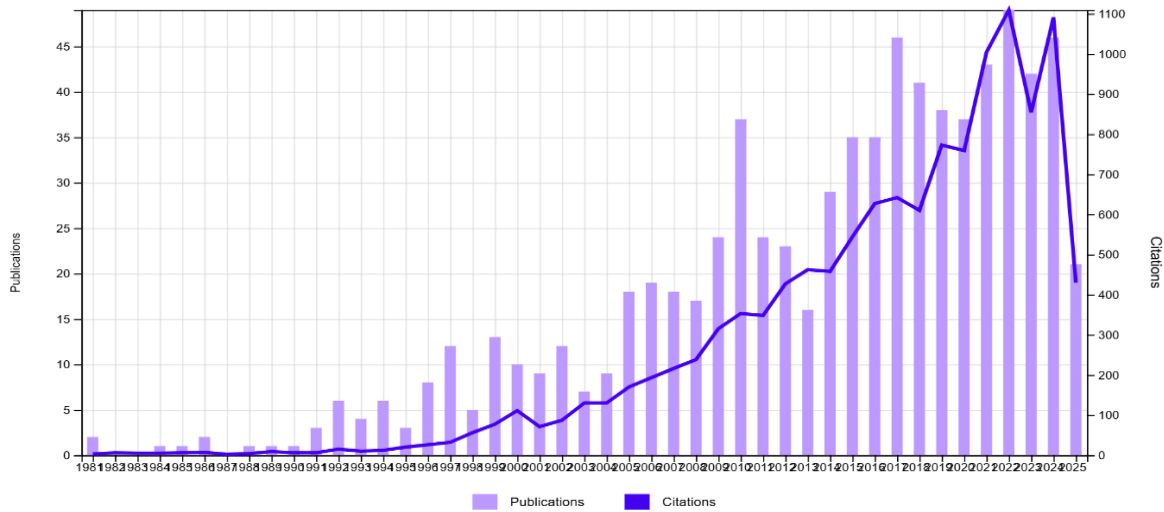


Figure 2. Distribution of Publications and Citations by Year (1981-2025)

The graph shows that the number of citations has increased faster than the number of publications. A significant portion of this increase in citations, 63.40%, has occurred in the last 10 years. At the same time, the average number of citations per study is 11.3 (Table 1). The studies confirm the growing interest of researchers in the field of occupational safety since the late 1990s (Özdemir & Kayabaşı, 2024). The fact that newer studies in the field of OHS in agriculture receive more citations than older ones can be attributed to the increase in the number of articles in recent years and the fact that more current topics are being addressed.

The top 15 most cited studies are listed in Table 2. Among the most cited articles, the article titled “Immigrant populations, work and health - a systematic literature review” by Ahonen et al. (2007) ranks first with 292 citations. The purpose of the article is to analyze the information obtained from studies on the OHS of immigrant workers. Table 2 also includes two separate articles that examine migrant agricultural workers from different perspectives. McCurdy et al. (2003) examined injuries among migrant agricultural workers and concluded that the risk of agricultural injury increased among women paid by the piece and that sprains and strains were the most common injuries. Arcury et al. (2010) focused on the challenges of providing health and safety training to migrant agricultural workers in the United States with limited English language skills and educational attainment. The study includes recommendations for improving appropriate health and safety training materials.

Table 2. The Top 15 Most Frequently Cited Articles

No	Title	First Authors	Source Title	Year	Doi	Total Citations
1	Immigrant populations, work and health - a systematic literature review	Ahonen, Emily Q.	Scandinavian Journal of Work Environment & Health	2007	10.5271/sjweh.1112	292
2	Modeling farmers' intention to use pesticides: An expanded version of the theory of planned behavior	Bagheri, A.	Journal of Environmental Management	2019	10.1016/j.jenvman.2019.109291	173
3	Agricultural injury	McCurdy, SA	American Journal of Industrial Medicine	2000	10.1002/1097-0274(200010)38:4<463::AID-AJIM13>3.3.CO;2-E	169
4	Osteoarthritis of the hip - an occupational-disease in farmers	Croft, P.	British Medical Journal	1992	10.1136/bmj.304.6837.1269	168
5	Preventing heat-related illness among agricultural workers	Jackson, L.L.	Journal Of Agromedicine	2010	10.1080/1059924X.2010.487021	138
6	A systematic review of farm safety interventions	DeRoo, L.A.	American Journal of Preventive Medicine	2000	10.1016/S0749-3797(00)00141-0	137

Table 2. The Top 15 Most Frequently Cited Articles (Continued)

7	Osteoarthritis of the hip and knee and mechanical occupational exposure - A systematic overview of the evidence	Maetzel, A.	Journal of Rheumatology	1997	-	125
8	Fatal work-related farm injuries in Canada, 1991-1995	Pickett, W.	Canadian Medical Association Journal	1999	-	118
9	Understanding the ergonomic risk for musculoskeletal disorders in the United States agricultural sector	Davis, K. G.	American Journal of Industrial Medicine	2007	10.1002/ajim.20479	117
10	Agricultural injury in California migrant Hispanic farm workers	McCurdy, S.A.	American Journal of Industrial Medicine	2003	10.1002/ajim.10272	114
11	Overcoming language and literacy barriers in safety and health training of agricultural workers	Arcury, T.A.	Journal of Agromedicine	2010	10.1080/1059924X.2010.486958	107
12	Agricultural injuries among older Kentucky farmers: The farm family health and hazard surveillance study	Browning, S.R.	American Journal of Industrial Medicine	1998	10.1002/(SICI)1097-0274(199804)33:4<341::AID-AJIM4>3.0.CO;2-X	105
13	Ergonomic risks and musculoskeletal disorders in production agriculture: Recommendations for effective research to practice	Kirkhorn, S. R.	Journal of Agromedicine	2010	10.1080/1059924X.2010.488618	104
14	Low back pain and musculoskeletal symptoms among Kansas farmers	Rosecrance, J.	American Journal of Industrial Medicine	2006	10.1002/ajim.20324	101
15	Use of protective equipment among California farmers	Schenker, M.B.	American Journal of Industrial Medicine	2002	10.1002/ajim.10134	98

One of the topics frequently addressed by researchers is “agricultural injuries”. McCurdy & Carroll (2000); by examining the MEDLINE and NIOSH-TIC databases, they analyzed studies addressing occupational injuries among agricultural workers in North America. It was found that male agricultural workers and cattle workers were in the high-risk group and that falls, machinery, and animals were among the most common causes of injury. A systematic review conducted by DeRoo & Rautiainen (2000) examined 25 studies addressing farm safety intervention programs. Additionally, in a study conducted by Browning et al. (1998), agricultural injuries experienced by 998 farmers living in Kentucky over the course of a year were tracked. Injuries that occur are listed as falls, machinery, wood cutting, and incidents involving animals.

Occupational diseases among agricultural workers are another area of study with a high number of citations. Osteoarthritis is the prominent topic. Articles: Hip osteoarthritis is particularly prevalent in individuals who have been farming for more than 10 years, with higher rates compared to the control (Croft et al. 1992), and a consistent positive relationship between jobs involving knee bending and knee osteoarthritis in men was found (Maetzel et al., 1997). Heat-related illnesses can develop and be fatal in agricultural workers due to high exertion and environmental conditions. To prevent heat-related illnesses in agricultural settings, it is necessary to create an environment where safe working practices are implemented and where employers, managers, and workers share the responsibility for preventing heat-related illnesses (Jackson & Rosenberg, 2010).

Ergonomic risks in the agricultural sector are among the most prominent and frequently addressed issues. Non-ergonomic working conditions often lead to musculoskeletal disorders (MSDs). Researchers have identified the most frequently cited topics as current research on ergonomic solutions, musculoskeletal disorders encountered in the agricultural sector, factors associated with occupational back pain in farm workers, tools, vehicles, or equipment developed for MSDs, and ergonomic solutions including work practices (Rosecrance et al., 2006; Davis & Kotowski, 2007; Kirkhorn et al., 2010) were the most frequently cited topics. The study conducted on farmers' use of personal protective equipment has been one of the most cited studies in this field. A telephone survey was conducted with 1,947 California farmers, and it was found that farmers who were concerned about health issues were much more likely to use protective equipment. Risto H. Rautiainen has contributed the most to OSH studies in the agricultural sector, with 33 articles. The United States and Canada stand out as the two countries where the authors are affiliated (Table 3).

Table 3. Authors who Contributed Most to OHS Studies in the Agricultural Sector (Ranked Based on the Number of Publications)

No	Authors	Institution titles	Country	Number of publications
1	Rautiainen R.H.	University of Nebraska Medical Center	USA	33
2	Pickett W.	Brock University	Canada	29
3	Lee B.C.	Marshfield Clinic Research Institute	USA	17
4	Quandt S.A.	Wake Forest University	USA	17
5	Arcury T.A.	Wake Forest University	USA	17
6	Field W.E.	Purdue University	USA	15
7	Marlenga B.	Marshfield Clinic Research Institute	USA	15
8	Stallones L.	Colorado State University	USA	14
9	Weichelt B.	Marshfield Clinic Research Institute	USA	14
10	Brison R.J.	Kingston General Health Research Institute	Canada	14
11	Murphy D.J.	Pennsylvania State University	USA	13
12	Gorucu S.	University of Florida	USA	12
13	Reed D.B.	University of Kentucky	USA	12
14	Hagel L.	University of Saskatchewan	Canada	11
15	Gerberich S.G.	University of Minnesota System	USA	10

The co-authorship analysis included 102 authors who met the criteria of at least 4 publications and 4 citations among 2423 authors. The co-authorship network map of 56 authors connected to each other is shown in Figure 3. Each node in the map corresponds to a researcher. The connections indicate collaboration between authors. Figure 3 shows that the authors form 8 distinct clusters. The authors with the highest connection strength and most open to collaboration are: William Pickett, with 16 publications, 360 citations, and 50 total link strength, located in the green cluster. Second is Thomas A. Arcury, with 15 publications, 382 citations, and 49 total link strength. Third is Sara A. Quandt, with 16 publications, 424 citations, and 49 total link strength. Thomas A. Arcury and Sara A. Quandt do not collaborate with the researchers shown in Figure 3. These two researchers belong to a different co-author network connection involving 8 separate authors. Risto H. Rautiainen, the most prolific author, is also at the center of the red cluster, which has the most nodes.

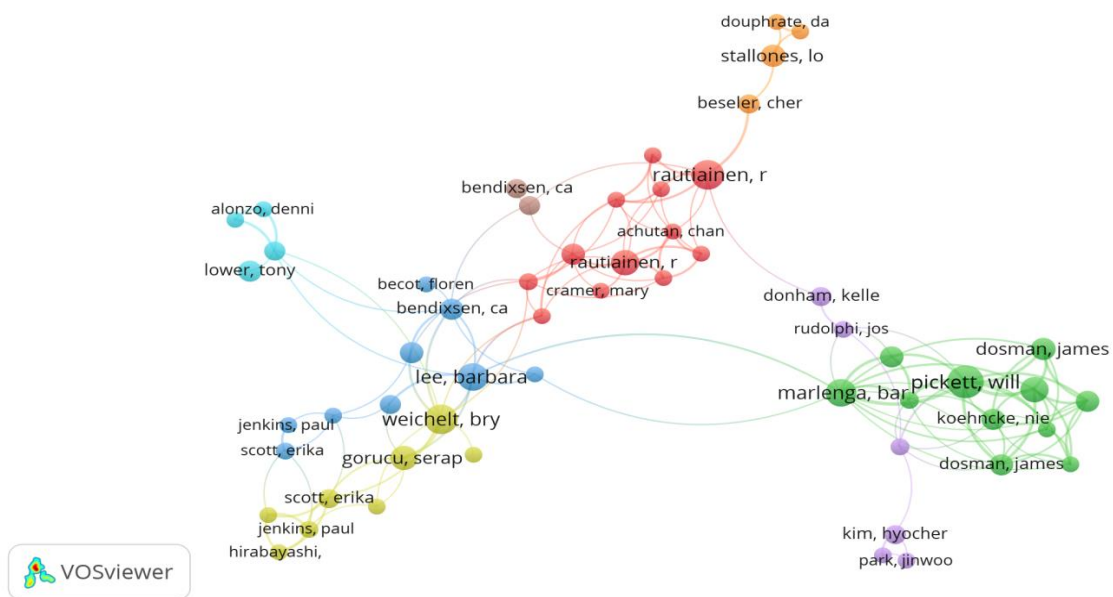


Figure 3. Co-authorship of Authors Network Map

Table 4 lists the top 10 journals that published the most articles on OHS in the agricultural sector out of a total of 267 journals.

Table 4. Top 10 Journals Publishing in the Field

No	Publication Titles	Record Count	%
1	Journal of Agromedicine	164	21.19
2	Journal of Agricultural Safety and Health	77	9.95
3	American Journal of Industrial Medicine	73	9.43
4	Frontiers In Public Health	20	2.58
5	Safety	16	2.07
6	Journal of Safety Research	15	1.94
7	Annals of Agricultural and Environmental Medicine	12	1.55
8	International Journal of Environmental Research and Public Health	12	1.55
9	Journal of Rural Health	12	1.55
10	Accident Analysis and Prevention	11	1.42

The Journal of Agromedicine (JA) ranks first with 164 publications (Table 4). JA is a peer-reviewed academic journal based in the USA and published four times a year. JA publishes translational research, reports, and editorials related to agricultural health, safety, and medicine under the themes of Practice, Policy, and Research. JA is a hybrid open access journal that is part of the Taylor & Francis Open Select publishing program and offers you the option of open access publishing (Journal of Agromedicine, 2025). This journal is followed by the Journal of Agricultural Safety and Health with 77 studies and the American Journal of Industrial Medicine with 73 studies. The Journal of Agricultural Safety and Health is an interdisciplinary, peer-reviewed journal designed to encourage the identification and discussion of agricultural safety and health issues (ASABE, 2025). The American Journal of Occupational Medicine is published to develop and share information that promotes the prevention of illness and injury in the fields of occupational and environmental health and safety (American Journal of Industrial Medicine, 2025). These three journals have published 40.57% of the studies related to OHS in the agricultural sector.

A journal citation analysis was performed for the 10 journals listed in Table 4. The 10 journals included in the network map prepared in Vosviewer software met the criteria of publishing at least 10 articles and receiving at least 10 citations (Figure 4).

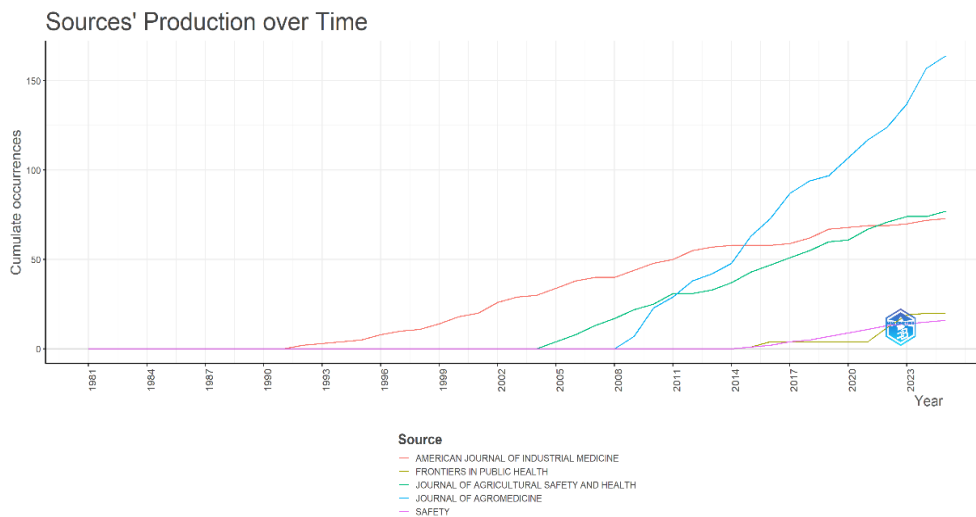


Figure 4. Publication Performance of the Top 5 Journals by Year (1981–2025)

Each node in Figure 5 corresponds to a journal. Based on citation counts, the American Journal of Industrial Medicine, with 2,606 citations, is located at the center of the network map. It is followed by the Journal of Agromedicine with 1,914 citations and the Journal of Agricultural Safety and Health with 616 citations. There is a dense citation relationship between these journals. It can be said that the studies included in the dataset frequently cite research published in these three journals.

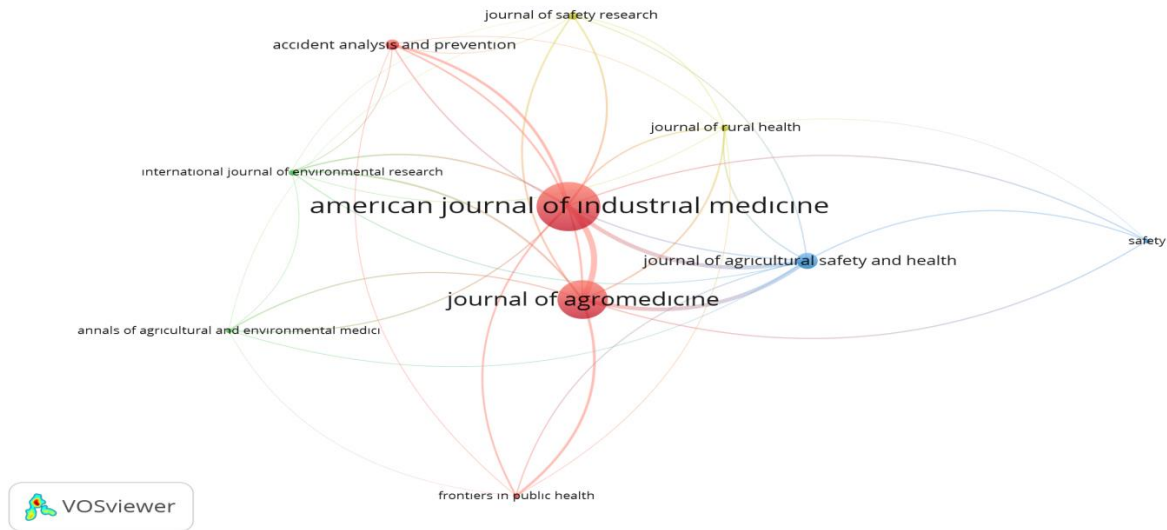


Figure 5. Journal Citation Network Map

University of Nebraska Medical Center (UNMC) stands out in the field of OHS in the agricultural sector with 47 publications (Table 5) UNMC consists of six faculties, a graduate education program, two degree-granting institutes, and a large research institute. It houses the Central States Center for Agricultural Safety and Health. The center collaborates with the agricultural community in the Central States and beyond. Its mission is to conduct research, interventions, education, and outreach activities. These efforts focus on identifying the mechanisms of injury and illness, as well as developing, implementing, and evaluating prevention strategies. The ultimate goal is to measurably improve the health and safety of members of the agricultural community (UNMC, 2025). The University of Iowa follows this institution with 37 publications. The University of Iowa is one of America's leading public research universities and offers over 200 majors, minors, and certificate programs (UIOWA, 2025).

The institutions with the most studies in the field of OHS in the agricultural sector are listed in Table 5.

Table 5. Top 10 Contributing Institutions

No	Affiliations	Record Count	%
1	University of Nebraska Medical Center	47	6.07
2	University of Iowa	37	4.78
3	Queens University	31	4.01
4	University of California System	31	4.01
5	Marshfield Clinic Research Institute	28	3.62
6	University of Kentucky	28	3.62
7	Pennsylvania State University	26	3.36
8	Colorado State University	25	3.23
9	Centers For Disease Control Prevention	23	2.97
10	National Institute for Occupational Safety Health	22	2.84

Collaborations between higher education institutions contribute to the sharing of resources, knowledge, and expertise, while also enabling them to carry out research and development projects beyond their capacities (Veretennik & Shakina, 2023). In the field of OHS in the agricultural sector, citation network analysis, particularly among universities, is important for identifying the most effective institutions and opportunities for collaboration. Citation network analysis was performed for 23 institutions that met the criteria of at least 10 articles and 10 citations among a total of 825 organizations, and the results are presented in Figure 6. In the inter-institutional collaboration network analysis, the universities or research institutions to which the authors in the dataset are affiliated are taken as the basis. Each organization is represented by a node. It is possible to say that institutions in the same color cluster collaborate on similar topics.

The upper right quadrant identifies motor themes (well-developed and important themes for structuring a research area). The upper left quadrant depicts niche themes (themes of limited importance to the field). The lower right quadrant contains emerging or declining themes (weakly developed and marginal themes). The lower left quadrant contains fundamental themes (general topics important to researchers) (Xi & Suhaiza, 2025; Aria et al., 2021).

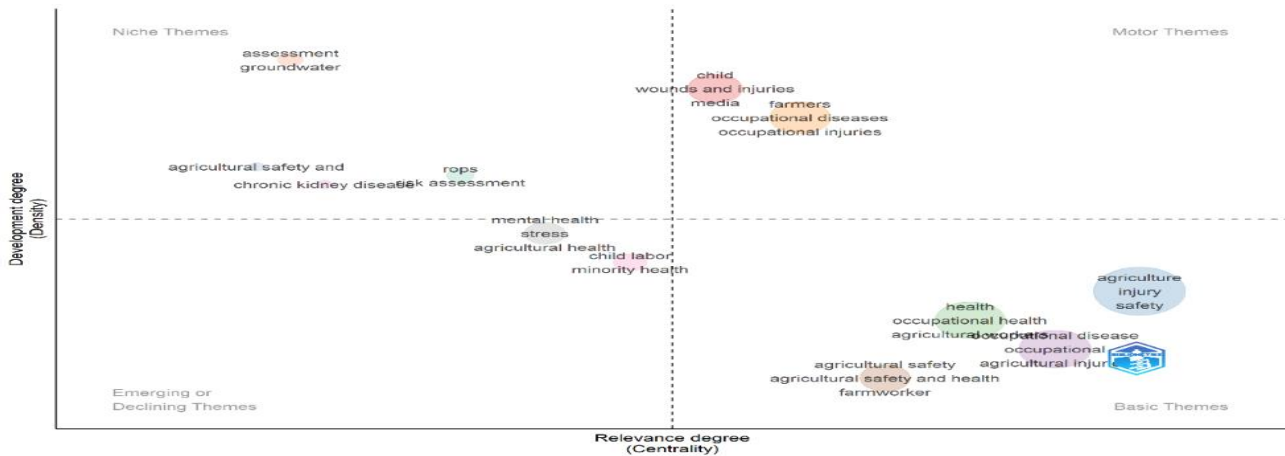


Figure 8. Thematic Map

The thematic map was created using keywords belonging to the authors. Among the basic themes that form the foundation of the subject in the thematic map are the keywords agriculture, health, occupational disease, and agricultural safety. Located closer to the center and reflecting the interest in the subject, the motor themes that researchers frequently work on include the concepts of child, farmers’ occupational disease, and occupational injury. Niche themes such as assessment, agricultural safety and health, ROPS, and risk assessment point to new research topics that have not been sufficiently studied. Themes that are newly being studied or are declining include keywords such as mental health, stress, child labor, and minority health.

Figure (9-a) shows the keyword network map for studies addressing OHS in the agricultural sector. A total of 127 words, which met the criterion of being used at least 4 times out of 1,877 words, formed 6 distinct clusters with no fewer than 10 nodes. Upon examining Figure (9-a), it can be seen that the cluster with the most nodes is the “red” cluster, with 33 nodes. The largest node in this cluster, which focuses on farm injuries, is “injury,” appearing in 71 separate articles and having a total connection strength of 196. The nodes belonging to the red cluster appear scattered throughout the other clusters. This situation can be interpreted as the “agriculture injury” theme being frequently used in conjunction with themes in other clusters. The second cluster is the green cluster with 23 nodes. The most frequently used keyword in this cluster is agricultural safety (34), followed by occupational health (24), farmworkers (17), and occupational safety (16). The green cluster points to studies conducted on workers regarding health and safety concepts. The blue cluster is in third place and has 22 nodes. The largest node in the network map, “agriculture” (259), is in this cluster and is also at the center of the network map. The blue cluster consists of studies on occupational diseases and musculoskeletal disorders. In the yellow cluster, which is in fourth place, “farm safety” (47) is the prominent keyword. The keywords “children” (30) and ‘youth’ (30) stand out in this cluster, suggesting that studies on groups working in the agricultural sector that require special policies are grouped in this cluster. The fifth cluster is the purple cluster, which has 17 nodes. The most frequently used keyword in this cluster is “safety” (72). This is followed by the keywords farm (46) and epidemiology (29). This cluster deals with epidemiological studies related to diseases, accidents, injuries, and deaths in the agricultural sector. Cluster 6 is the turquoise cluster with 14 nodes. Occupational disease (26) is the most frequently repeated keyword.

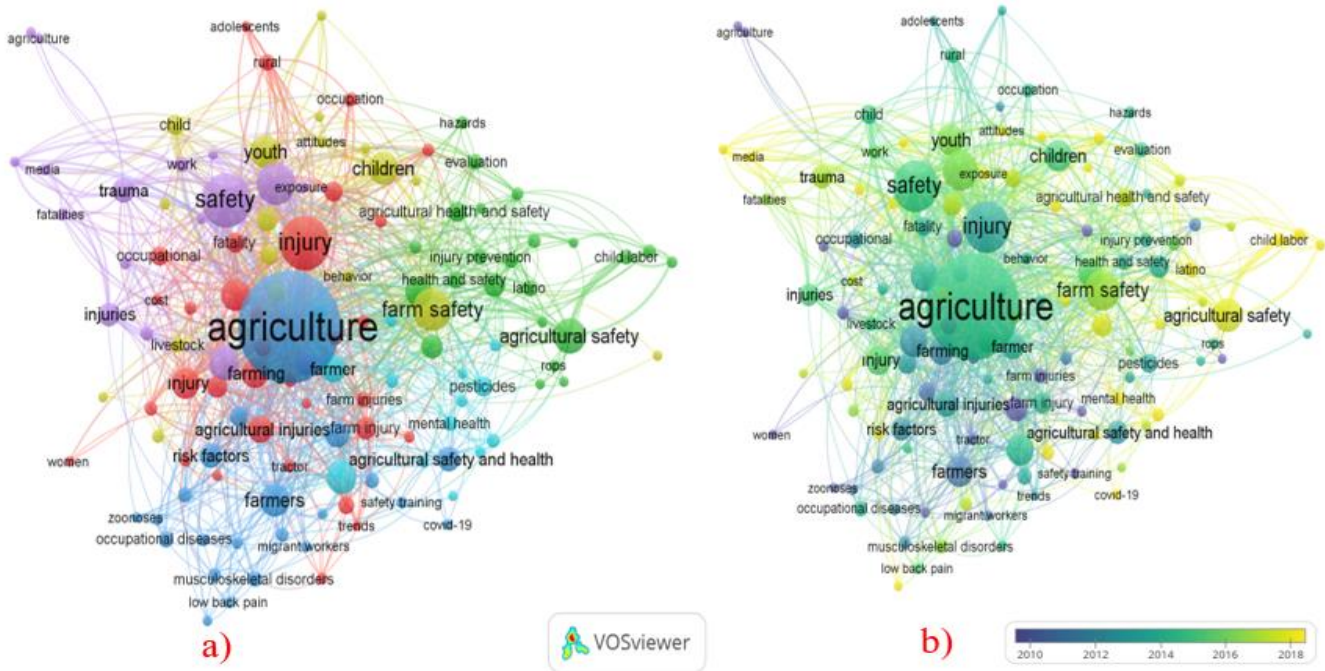


Figure 9. Keyword Co-occurrence Network Map (a) and Co-occurrence Network Map Over Time (b)

Figure (9-b) shows a network map depicting the distribution of keywords by year. Colors shifting toward yellow indicate studies conducted in recent years. When “agriculture,” the largest node in the network map, is taken as a reference, the prominent keywords are mental health, stress, COVID-19, risk factor, training, attitudes, outreach, child labor, vulnerable populations, and minority health. These keywords are also newly researched terms that may provide ideas to researchers.

Sankey diagrams reflect directed and weighted graphs with weight features that fulfill flow preservation (Kumar et al., 2021). In Biblioshiny version 5.0, the “Three-Field Plot” option allows you to visually display the relationship between three selected fields from the following options: authors, affiliations, countries, keywords, titles, abstract, sources, references, and cited sources. (Figure 10) shows a Sankey Diagram illustrating the relationship between author keywords (left), author (center), and source (right). The journal “Journal of Agromedicine” has the most keywords and authors associated with it. Table 2 supports the results by showing that “In line with previous findings, the Journal of Agromedicine occupies a central position”.

The keywords most frequently used together by authors were “agriculture,” “safety,” and “injury.” Pickett, Weichert, and Rautiainen preferred to use these keywords in their publications in the Journal of Agromedicine, the Journal of Agriculture Safety and Health, and the American Journal of Industrial Medicine.

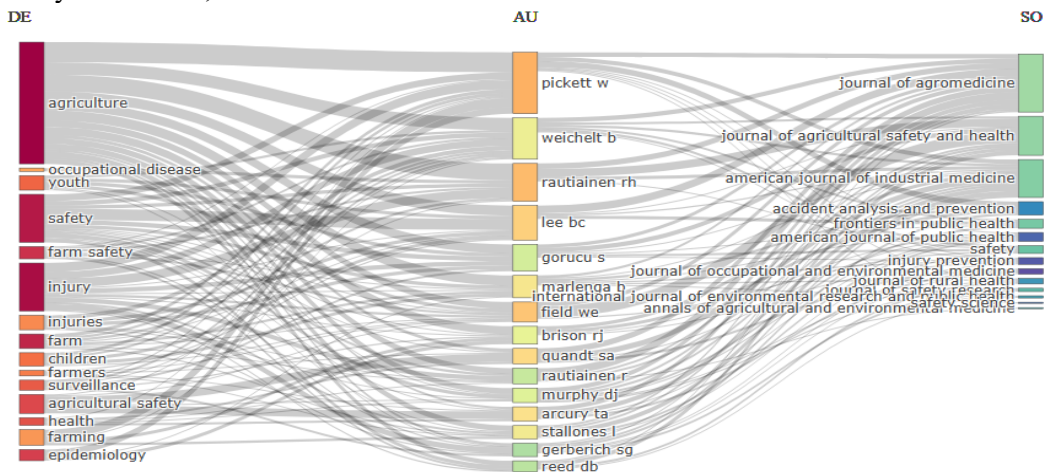


Figure 10. Three-field Plot (Keywords, Authors and Sources)

Trend author keyword analysis was performed using the biblioshiny library in the bibliometrix package of R Studio software (Figure 11). For the analysis covering the years 1981-2025, the minimum word frequency was set to 6 and the number of words per year was set to 3.

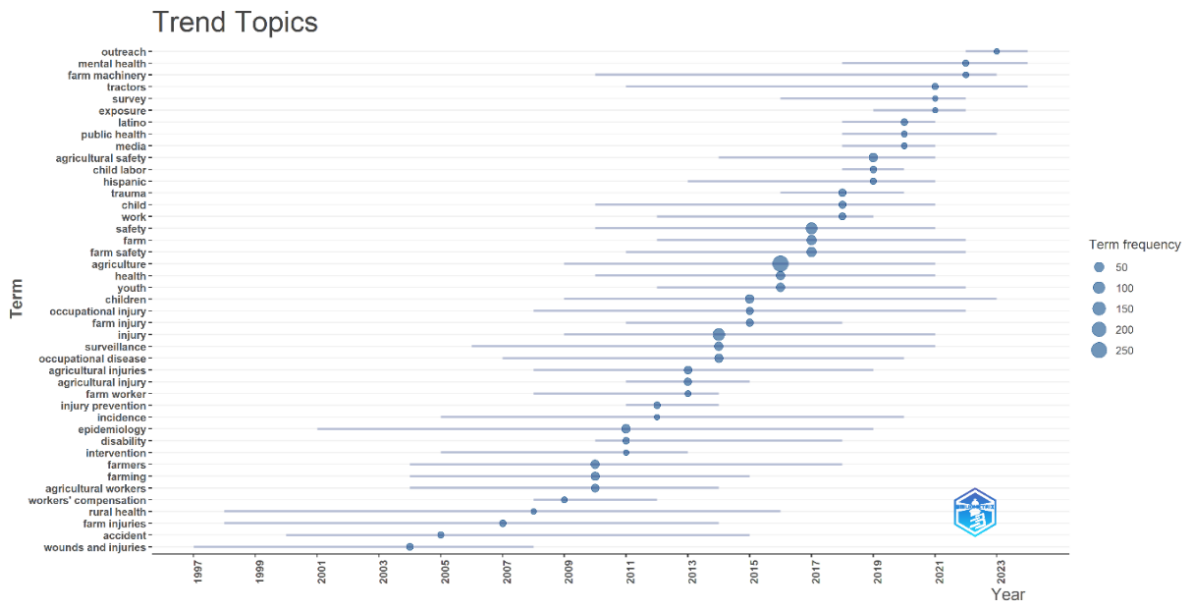


Figure 11. Trending Author Keywords by Year

In their early studies, researchers focused on the keywords “farm injuries,” “accident,” “wounds and injuries,” and “epidemiology.” Based on these keywords, it can be said that work accidents in the agricultural sector and health risks affecting agricultural workers were examined using epidemiological methods. In recent years, however, the keywords “outreach,” “mental health,” “farm machinery,” and “tractors” have come to the fore. It can be said that researchers' interest has shifted from accidents encountered in the agricultural sector to mental health, and that the words ‘stress’ and “depression” (Figure 11) are primarily related words. Increasing food demand, concerns about productivity in the food sector, etc., have also made mechanization and the use of new technologies in agriculture a necessity. The studies in the dataset have been heavily associated with the terms “farm safety” and “injury,” and research has been shaped to ensure safety in the agricultural sector.

CONCLUSIONS

This study aims to provide a systematic bibliometric evaluation of OHS studies in the agricultural sector between 1981 and 2025. Publications on OHS in the agricultural sector significantly increased between 2014 and 2024, reaching their peak in 2022 with 49 publications and 1,109 citations. The citation analysis results revealed that the most productive and leading article on OHS in the agricultural sector was the article titled “Immigrant populations, work and health - a systematic literature review” published in the “Scandinavian Journal of Work Environment & Health” by (Ahonen et al., 2007). The most productive and dominant source related to the topic was the US-based “Journal of Agromedicine”. Author R.H. Rautiainen published the most articles on OHS in the agricultural sector, followed by W. Pickett. The US-based “University of Nebraska Medical Center” emerged as the top institution.

The United States is the leading country in terms of knowledge production, number of citations, and collaboration in the field of OHS in the agricultural sector. According to agricultural production value data in US dollars published by the (FAO, 2025), the top ten countries are ranked as follows: China, India, the United States, Brazil, Indonesia, Russia, Türkiye, France, Japan, and Mexico. Although China, Brazil, and India present a profile of economically strong agricultural countries, it can be said that they are still in the development phase in terms of scientific production and collaboration in the field of OHS in the agricultural sector.

Agriculture, safety, injury, farm safety, farm, agricultural safety, and farm safety are the most frequently used keywords related to this topic. These words are also among the “basic” themes on the thematic map. They can be considered concepts that continue to shape OSH issues in agriculture and can be analyzed in depth using theoretical and empirical methods. Keyword and trend analyses have linked keywords such as farm machinery, tractors, child labor, mental health, stress, ergonomic, and outreach to new trends related to the topic.

In addition to external factors such as long working hours, heavy physical workload, and challenging weather conditions, social factors such as income concerns, uncertainty, economic fluctuations, and the solitary nature of the work negatively affect the mental health of agricultural workers (Dawes & Franklin, 2025). Recent literature has reached a consensus that mental health issues in agriculture are an emerging problem and that fundamental knowledge gaps need to be addressed (Nye et al., 2025).

Agricultural mechanization has become necessary to make agricultural food systems more sustainable in terms of various economic and social aspects such as labor productivity, poverty reduction, food security, health, and well-being (Daum, 2023). Despite the rapid spread of mechanization in the agricultural sector, the need for research on the occupational safety and health implications of automation continues (Lincoln et al., 2025). While research on the use of agricultural mechanization and automated production systems revolves around the concepts of cost and efficiency (Zhao, 2026; Yan et al., 2025), the concept of “farm machinery,” which is among the trending topics in the study, shows that researchers address the issue in the context of OSH.

Although the focus has primarily been on environmental and economic concerns, OSH has a significant impact on sustainable agriculture (Caffaro et al., 2022). Similarly, organic farming has emerged as an important alternative to conventional farming, aiming to eliminate the negative effects of traditional farming practices on the environment and human health (Bozdemir & Azkeskina, 2025). On the other hand, the use of machinery and digital technologies in agricultural production processes offers promising strategies to support agricultural growth by increasing scale, efficiency, and effectiveness (Värzaru, 2025). The “author keywords” trends in the study's dataset also confirm that researchers have begun to focus on these concepts, albeit weakly, in the context of enhancing security in the agricultural sector.

Ergonomic and psychosocial risk factors affecting agricultural workers suggest that the subject is expanding through a multidisciplinary approach. In the agricultural sector, an interdisciplinary OSH approach ILO (2019) that brings together disciplines such as medicine, engineering, automation, health technologies, nutrition, public health, psychology, sociology, and economics can develop appropriate policies to prevent the hazards and risks to which workers are exposed. To this end, close cooperation must be established between policymakers, universities, relevant public institutions, professional associations, and unions. In addition to legal regulations specific to the agricultural sector, it is critically important to strengthen oversight mechanisms through guidance and cooperation networks.

Scientific analyses of occupational accidents and occupational diseases in the agricultural sector, along with regulatory updates and the development of preventive and remedial activities in agricultural fields over the years, will play an effective role in reducing material and moral losses. Comprehensive training programs should be developed that include case-based analyses focusing on the dangers and risks practitioners encounter in the field. When designing these programs, the issue of child labor should be given special consideration; priority should be given to preventive and awareness-raising content aimed at protecting children within the framework of age-related vulnerabilities, developmental risks, and dimensions of non-compliance with legislation. In addition, targeted intervention strategies should be developed for groups requiring special policies (women, migrants, seasonal agricultural workers, and children). Furthermore, comprehensive programs should be implemented that prioritize not only the physical health of practitioners but also the protection of their psychosocial well-being and mental health.

This study has several limitations. It relies solely on the WoS Core Collection database, which may exclude relevant literature indexed elsewhere (e.g., Scopus). Future studies could broaden the scope by using more extensive databases. Furthermore, more in-depth analyses could be conducted using content or systematic analysis.

Artificial Intelligence Contribution Statement

This article was written, analyzed, and prepared without the use of artificial intelligence tools (used only for paragraph formatting). The text, including data analysis and figures, was created solely by the authors. (If used, it should be specified in detail.)

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